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Draft Reclamation Program Plan For Site Characterization

***Yucca Mountain Project
Yucca Mountain Project Office***

August 1989

***U.S. Department of Energy
Office of Civilian Radioactive Waste Management***

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Yucca Mountain Project
Yucca Mountain Project Office

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U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, DC 20585

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RECLAMATION PROGRAM PLAN FOR SITE CHARACTERIZATION

SUMMARY

As part of its obligations under the Nuclear Waste Policy Act, as amended, the U.S. Department of Energy (DOE) has developed an environmental program that is to be implemented during site characterization at the Yucca Mountain site. This site is proposed for the location of the nation's first high-level radioactive waste repository. A program for the reclamation of areas disturbed by site characterization is part of the overall environmental program for that site.

This Reclamation Program Plan (RPP) describes the reclamation policy of the DOE for the Yucca Mountain site and presents an overview of the reclamation program. The RPP also provides an overview of the reclamation needs relative to site characterization; a review of legislation and requirements pertinent to reclamation; and a review of previous commitments made by the DOE to certain types of reclamation activities.

The objective of the DOE reclamation program at Yucca Mountain is to return land disturbed by site-characterization activities to a stable ecological state with a form and productivity similar to the predisturbance state. The DOE will take all reasonable and necessary steps to achieve this objective.

The DOE will develop site-specific reclamation instructions for all areas disturbed by site characterization, including those areas disturbed during repository-related field activities before the onset of the site-characterization program. To the extent possible, reclamation activities will be consistent at all locations and on lands under all jurisdictions.

Each disturbed area will be reclaimed as soon as practicable following determination that the area is no longer needed for the site-characterization program.

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In all cases, decisions regarding the timing of reclamation will be based on the needs of the site-characterization program. If the Yucca Mountain site is found to be unsuitable for development as a repository, reclamation will proceed immediately on those areas remaining to be reclaimed. If the Yucca Mountain site is found unsuitable for development as a repository, but an alternative use for developed facilities is established, reclamation will be limited to those areas deemed not needed for the proposed alternative use. If the Yucca Mountain site is found suitable for repository development, reclamation will be implemented in all areas not needed for operation of the repository.

The reclamation activities planned for site characterization can be placed into four categories: reclamation feasibility studies, interim reclamation activities, final reclamation activities, and postreclamation monitoring. These activities will be described in detail in the Reclamation Implementation Plan now being developed. A Reclamation Feasibility Plan has been developed to determine effective approaches to reclamation in the arid environment of Yucca Mountain. Preactivity surveys will be conducted to determine soils and ecological characteristics at each area prior to disturbance under the site-characterization program. The information obtained in these surveys will be used to determine the interim reclamation activities, including topsoil salvage specifications and erosion-control measures.

Once an area has been designated for reclamation, decommissioning will be conducted to remove and dispose of all man-made materials and wastes resulting from site-characterization activities. Prereclamation surveys will be conducted to develop site-specific reclamation instructions for each area. These instructions will include specifications on contouring, topsoil treatment and redistribution, and revegetation methods. Areas where reclamation activities have occurred will be monitored for several years to determine the success of reclamation at each area. Additional reclamation activities will be employed if necessary to meet established reclamation criteria.

1 INTRODUCTION

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The U.S. Department of Energy (DOE) is in the process of determining the suitability of the Yucca Mountain site in Nye County, Nevada, for the nation's first high-level radioactive waste repository. A site-characterization program has been developed to obtain the geotechnical information needed to determine suitability of the site. In conjunction with this program, the DOE has developed an overall environmental program for the Yucca Mountain site. This program is described in the Environmental Program Overview (DOE 1988a) and includes plans for reclamation of areas disturbed during the site-characterization process.

1.1 PURPOSE AND SCOPE

This Reclamation Program Plan (RPP) defines the reclamation policy of the DOE for the Yucca Mountain site and presents an overview of the reclamation program for that site. The RPP also provides an overview of the reclamation needs relative to site characterization; a review of the legislation and requirements pertinent to the reclamation of areas disturbed during site characterization; and a review of previous commitments made by the DOE to certain types of reclamation activities. Policy issues discussed in the RPP include (1) reclamation objective, (2) consistency of reclamation practices across the Yucca Mountain site, and (3) timing of reclamation. Other reclamation-related documents have been or are being prepared to describe the technical details of the reclamation program. These documents are described in Sec. 4.

Reclamation activities are those activities employed to return disturbed land to some predetermined condition. As used in this document, reclamation includes the decontamination and decommissioning of disturbed areas (where appropriate) and steps to stabilize soils and establish a vegetative cover. A need for decontamination (the selective removal of radioactive contaminants from the site), is not anticipated because

site-characterization activities are not expected to introduce radioactive contaminants to the site (see Sec. 8.7 of the Site Characterization Plan [SCP] [DOE 1988b]). Decommissioning (the placement of facilities developed during site characterization in a permanently nonoperable, safe condition) will be required at many locations. Decommissioning activities include the removal of all aboveground, man-made structures and wastes from each facility (e.g., drill pads, road surfacing materials, equipment, buildings, utilities) and the closing and sealing of boreholes.

1.2 Summary of Site-Characterization Activities

The SCP provides detailed descriptions of the site-characterization activities proposed at Yucca Mountain. Site-characterization activities will be conducted in accordance with generally accepted practices to minimize or eliminate any significant adverse environmental impacts. For example, when possible, facilities will not be constructed on environmentally sensitive areas, such as steep slopes or water courses. The DOE has developed an Environmental Monitoring and Mitigation Plan (EMMP) (DOE 1988c) designed to ensure that any significant adverse environmental impacts will be minimized to the maximum extent practicable. Minimization of adverse environmental impacts during site characterization will facilitate any reclamation of the Yucca Mountain site and will reduce the extent of any reclamation required after the completion of a specific site-characterization activity.

Proposed site-characterization activities are expected to result in the disturbance of approximately 180 ha (440 acres) at the Yucca Mountain site. About 375 ha (930 acres) of land have already been disturbed on and in the vicinity of the Yucca Mountain site during repository-related activities initiated in 1978 and as a result of activities unrelated to the repository. To illustrate the types of disturbances that will require reclamation, this section briefly describes proposed site-characterization

activities and previous repository-related disturbances at the site. Estimates of the amount of area to be disturbed by site characterization were obtained from the SCP.

1.2.1 Field Activities

The geotechnical field studies program (exploratory borehole drilling, hydrologic testing and monitoring, geophysical surveying, and field mapping) will involve drilling operations, trenching activities, pavement studies, access road construction, and geophysical surveys. An estimated total of 160 ha (395 acres) of land will be disturbed for all field activities. The principal features that will require reclamation after site characterization include borehole drilling pads and access roads.

Several hundred boreholes will be drilled as part of these field activities and are expected to disturb about 51 ha (125 acres). Site preparation for exploratory drilling activities will involve cut-and-fill, grading, and excavation. These activities will require disruption and removal of vegetation and surficial materials. Drilling of the approximately 50-60 deep boreholes will require extensive surface preparation and in most cases will include a raised and leveled dirt drill pad, parking area, equipment yard, and, for a few (8-12), a mud-and-cuttings pit. Little surface preparation and disturbance will be required for shallow boreholes that will be drilled with truck-mounted drilling rigs near existing and proposed access roads.

Trenches required for tectonic and paleohydrologic studies will be dug with earth-moving equipment. The material excavated during these trenching operations will be stockpiled adjacent to the trenches. An estimated 6 ha (15 acres) of land will be disturbed by trenching activities. In addition, pavement studies will be conducted to provide information concerning bedrock fracture patterns and for hydrologic modeling. Pavements (bedrock surfaces with little or no covering of soil or unconsolidated rock materials) will be cleared of cover for the study of fracture patterns by spraying water or air under moderately high pressure. Displaced materials will collect in adjacent

areas. The total area disturbed by these investigations is expected to be less than 0.4 ha (1 acre).

Dirt or gravel access roads to many of the drillhole and trench locations will have to be constructed or improved. Such roads will be either two-lane dirt or gravel roads or one-lane dirt tracks or trails. Road construction is expected to disturb about 51 ha (125 acres). Other construction activities (e.g., laydown or turnaround areas) will result in disturbance of about 24 ha (60 acres) of land.

Geophysical surveys will include seismic monitoring; reflection/refraction surveys; three-dimensional vertical seismic profiles; and gravity, magnetic, magneto-telluric, and resistivity surveys. Each survey will require land surveying and geologic reconnaissance either by foot, off-road vehicles, or helicopters. It is estimated that these surveys will disturb a total of about 28 ha (70 acres) of land.

1.2.2 Exploratory Shaft Facility

The Exploratory Shaft Facility (ESF) will be constructed to gain access to the potential repository horizon and to perform in-situ tests for site characterization. Development of the ESF will require the construction or improvement of (1) the shafts, underground rooms, and support buildings and structures; (2) access roads; and (3) utility services. These activities will result in a total surface disturbance of about 18 ha (45 acres) of land.

The ESF will consist of two vertical shafts (Exploratory Shaft No. 1 [ES-1] and Exploratory Shaft No. 2 [ES-2]), underground excavations constructed horizontally from the shafts (drifts), underground test facilities, and numerous aboveground facilities to support the excavation of the shafts. The ESF area will be cleared of vegetation, graded, and covered with gravel. Several leveled pads will be needed to accommodate the entrances to the exploratory shafts, their associated buildings, a water tank, equipment storage areas, explosive storage area, mine wastewater pond, sewage collection system,

and muck storage area. Site preparation for ES-1 and ES-2 will require cut-and-fill operations. The rock debris removed during the construction of ES-1, ES-2, and the ESF drifts will be hoisted to the surface and deposited adjacent to ES-1. A road will be built to haul rock debris from the exploratory shafts to the rock storage area on the east side of the ESF. An existing access road will be improved and extended to the ESF, and additional roads will be constructed to the exploratory shaft pads, the explosive storage area, and the water storage tank area.

A surface electrical substation will be constructed at the ESF. An extension of an existing 69-kV overhead power line will be required. Water will be distributed from the J-13 well on the Nevada Test Site through an existing buried line. It is proposed that sanitary waste be collected and disposed of in a sewage system. An underground sewer line will connect all trailers and buildings at the ESF to the sewage system.

1.2.3 Previous Disturbances

Previous activities on the Yucca Mountain site have disturbed approximately 375 ha (930 acres) of land. These disturbances, similar to those described in Sec. 1.2.1, include 261 ha (646 acres) for roads and trails, 50 ha (124 acres) for drilling activities, 14 ha (35 acres) for seismic surveys, 6 ha (16 acres) for trenching, less than 1 ha (1 acre) for pavements, 20 ha (50 acres) for power lines, and 23 ha (58 acres) for other disturbances (e.g., laydown areas). Some, but not all, of the disturbances resulted from repository-related field activities initiated in 1978. Unrelated activities that have resulted in disturbances on the Yucca Mountain site include DOE activities on the Nevada Test Site and non-DOE activities on public lands of the site.

2 APPLICABLE LEGISLATION, REGULATORY REQUIREMENTS, AND DEPARTMENT OF ENERGY COMMITMENTS

In conducting site-characterization activities at the Yucca Mountain site, the U.S. Department of Energy (DOE) will meet all applicable environmental requirements set forth by federal laws and regulations, Executive Orders, and DOE Orders. The DOE will, as a matter of comity, address the concerns evidenced by state and local laws for which federal sovereign immunity has not been waived, to the extent that these regulations are not inconsistent with the DOE's responsibilities under the Nuclear Waste Policy Act as amended (NWPA), the Atomic Energy Act, and other federal statutes. These regulatory requirements and the DOE's plan to comply with them are discussed in the Environmental Regulatory Compliance Plan (ERCP) (DOE 1988d).

This chapter describes the legislation and regulatory requirements pertinent to the reclamation policy adopted by the DOE for site characterization at the Yucca Mountain site. In addition to existing legal requirements, several DOE documents contain commitments to reclaim the Yucca Mountain site following site characterization. These include the Mission Plan (DOE 1985a), the Yucca Mountain Environmental Assessment (EA) (DOE 1986), and the Site Characterization Plan (SCP) (DOE 1988b). These requirements and commitments are summarized in Table 1.

2.1 NUCLEAR WASTE POLICY ACT

The Nuclear Waste Policy Act of 1982 (NWPA) (42 U.S. Code [USC] 10101 et seq.), establishes the need to reclaim the Yucca Mountain site after completion of site characterization. Section 10133 of the NWPA states that "If the Secretary at any time determines the Yucca Mountain site to be unsuitable for development as a repository, the Secretary shall take reasonable and necessary steps to reclaim the site and to mitigate any significant adverse environmental impacts caused by site-characterization activities

TABLE 1 Legislation, Regulatory Requirements, and DOE Commitments Pertinent to Reclamation at the Yucca Mountain Site

Source	Pertinence to Reclamation
Nuclear Waste Policy Act	If site is found unsuitable, take reasonable and necessary steps to reclaim the site and mitigate any significant adverse environmental impacts.
National Environmental Policy Act	Basic federal environmental policy.
Federal Land Policy and Management Act; Bureau of Land Management Right-of-Way Reservation	<p>Prior to and during site use: Conduct pre-construction surveys; remove and stockpile topsoil; install erosion control devices; establish vegetative cover over bare soils.</p> <p>After site use: Remove or bury man-made structures and wastes; analyze topsoil and amend if necessary; ameliorate compaction; install erosion controls; redistribute topsoil; prepare seedbed and revegetate area; monitor reclamation success.</p>
DOE Order 5400.1 (DOE 1988e)	Protect, maintain, and (where necessary) restore environmental quality at DOE facilities.
DOE Order 6430.1 (DOE 1983)	Configure facilities to fit existing topography; minimize disturbance of ground forms and vegetation; use vegetation or mulch to minimize erosion; establish permanent vegetation as early as practical.
DOE Mission Plan (DOE 1985a)	Return the site, as nearly as practicable, to its original condition; remove man-made material and waste; backfill excavated areas and seal boreholes; recontour site; revegetate disturbed areas; monitor reclamation success.
Environmental Assessment (DOE 1986)	Stockpile topsoil; backfill excavated areas and seal boreholes; remove man-made materials and waste; ameliorate compaction; recontour site to reestablish drainage; revegetate disturbed areas with native or adapted species; study effectiveness of habitat restoration techniques.

TABLE 1 (Cont'd)

Source	Reclamation Requirements
Site Characterization Plan (DOE 1988b)	<p>Prior to and during site use: Gather information on soil depth and plant cover during preconstruction surveys; remove and stockpile topsoil; install erosion control devices; establish vegetative cover over topsoil stockpiles where appropriate; develop site-specific reclamation guidelines.</p> <p>After site use: Decontaminate area if necessary; remove or stabilize on the site all man-made structures and wastes; analyze topsoil and amend if necessary; ameliorate soil compaction; back-fill excavated areas and seal boreholes; regrade area to approximate original contours; redistribute topsoil; prepare seedbed and revegetate area with native or adapted species; monitor reclamation success.</p>

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at such site." Section 10133 also specifies that the SCP include "plans for the decontamination and decommissioning of such candidate site, and for the mitigation of any significant adverse environmental impacts caused by site characterization activities if it is determined unsuitable for application for a construction authorization for a repository." As outlined in this document, the reclamation program for the Yucca Mountain site also provides for reclamation (1) in the event the site is found suitable for development as a repository, and (2) before a determination of suitability is made if disturbed areas are no longer needed for site characterization.

The DOE, in implementing the NWPA, issued Code of Federal Regulations Title 10, Part 960 (10 CFR 960), *General Guidelines for the Selection of Sites for Repositories* (DOE 1984). Section 960.3-4 provides that the DOE is to consider environmental impacts throughout the site-characterization, site-selection, and repository-development process and to mitigate significant adverse environmental impacts to the extent practicable. In part, reclamation of disturbed areas serves to mitigate any significant adverse environmental impacts related to land disturbance that might result from site-characterization activities.

2.2 NATIONAL ENVIRONMENTAL POLICY ACT

The purpose of the National Environmental Policy Act of 1969 (NEPA; 42 USC 4321) is to "declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation . . ." The DOE established policy for implementation of NEPA by issuing guidelines (DOE 1987) and DOE Order 5440.1 (DOE 1985b).

The NWPA specifically excludes site characterization from the NEPA requirement of preparation of an environmental impact statement. In conducting site

characterization, the DOE must adhere to Secs. 101(b), 102(2)(A), and 102(2)(H) of NEPA, which are broad statements that pertain to overall protection of the environment by agencies implementing federal programs. Reclamation of land disturbed by site characterization will serve, in part, to prevent environmental degradation.

The Council on Environmental Quality (CEQ) issued regulations for implementing NEPA (40 CFR 1500-1508) (CEQ 1986). According to 40 CFR 1508.20:

"Mitigation includes:

- (a) Avoiding the impact altogether by not taking a certain action or parts of an action.
- (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
- (c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- (e) Compensating for the impact by replacing or providing substitute resources or environments."

This definition includes reclamation as a form of mitigation (item c) and is applicable to site characterization.

2.3 FEDERAL LAND POLICY AND MANAGEMENT ACT

The Federal Land Policy and Management Act of 1976 (FLPMA; 43 USC 1701) establishes U.S. policy with regard to federal lands administered by the Bureau of Land Management (BLM). As provided in 43 USC 1701(a)(8), it is U.S. policy that "The public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and

archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use."

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Federal activities requiring access to, and activity on, BLM-administered lands require compliance with FLPMA. Compliance by the DOE with BLM requirements is necessary for site-characterization activities because the Yucca Mountain site is located, in part, on BLM-administered public land and BLM-administered Air Force land (Nellis Air Force Base Range). The BLM issued a Right-of-Way Reservation to the DOE (under Title V of FLPMA), which stipulates that the DOE comply with specific environmental requirements, including those pertaining to reclamation. The Plan of Development (POD) (Exhibit A of the Right-of-Way Reservation) stipulates that ". . . reclamation will be used to return lands disturbed by site characterization to a stable ecological state with a form and productivity similar to the predisturbance state." These reclamation procedures would be implemented in three phases: (1) interim reclamation (those actions taken prior to area development and during area use); (2) final reclamation (those actions taken after an area has been abandoned); and (3) postreclamation monitoring (see Table 1). Interim reclamation activities will protect against soil loss and provide wildlife habitat. These activities include gathering information on soil depth and plant cover during preactivity surveys, removing and stockpiling topsoil, installing or constructing erosion-control devices before area development, and establishing vegetative cover over topsoil stockpiles (where appropriate) as soon as practicable. Final reclamation activities specified in the POD include decommissioning actions and those reclamation activities needed to revegetate disturbed areas. Postreclamation monitoring would continue until the area was judged completely reclaimed.

2.4 DEPARTMENT OF ENERGY ORDERS

2.4.1 DOE Order 5400.1

DOE Order 5400.1, *General Environmental Protection Program* (DOE 1988e) provides general direction for DOE programs to assure compliance with environmental protection laws and regulations, Executive Orders, and DOE policies. DOE Order 5400.1 states that "It is DOE policy to conduct its operations in an environmentally safe and sound manner." DOE Order 5400.1 also provides that "DOE is firmly committed to ensuring incorporation of national environmental protection goals in the formulation and implementation of DOE programs." The DOE is committed to advancing "the goals of restoring and enhancing environmental quality, and ensuring public health." Reclamation activities would serve to restore environmental quality following site characterization.

2.4.2 DOE Order 6430.1

DOE Order 6430.1, *General Design Criteria* (DOE 1983), contains general criteria to be considered in the acquisition of DOE facilities. Several of the criteria discussed in DOE Order 6430.1 (Chapter I, Sec. 3(j); Chapter XI, Sec. 5; Chapter XII, Sec. 7) are applicable to site characterization both in terms of siting facilities and in reducing erosion and runoff during construction (see Table 1). These criteria include minimizing disturbance of topographic features and vegetation, stabilizing soils through the use of mulch or vegetation, and establishing permanent vegetation as soon as possible following construction. Adherence to these criteria will facilitate reclamation of disturbed areas.

2.5 STATE AND LOCAL REQUIREMENTS

No existing State of Nevada or local regulations have thus far been identified that are applicable to reclamation of disturbances caused by site-characterization activities.

2.6 DEPARTMENT OF ENERGY COMMITMENTS

The DOE has made a number of commitments with regard to reclamation of lands disturbed by site-characterization activities at the Yucca Mountain site. These commitments are discussed below.

2.6.1 Mission Plan

As stated in the DOE Mission Plan (DOE 1985a, p. 366), "the general principle guiding the decommissioning strategy is that a site will be returned, as nearly as practicable, to its original condition." This principle is to be considered in the selection of study areas on the Yucca Mountain site, thus reducing the requirements for reclamation and enhancing the success of measures that are implemented. Under this approach, and consistent with the BLM Right-of-Way Reservation, site-specific reclamation planning would begin before an area is disturbed.

General guidance for reclamation of the Exploratory Shaft Facility and other disturbed areas is discussed in Sec. 7.6 of the Mission Plan. This guidance includes a list of appropriate decommissioning activities, such as removing buildings and equipment, closing shafts and boreholes, disposing of chemical wastes and materials stored in surface impoundments, and backfilling excavated areas. The Mission Plan also calls for grading of the site to a final contour consistent with existing land-use patterns or plans, revegetation, and monitoring to ensure compliance with the reclamation plans developed for the site (see Table 1).

2.6.2 Yucca Mountain Environmental Assessment

Commitments to reclaim areas disturbed by site characterization were made in the EA for the Yucca Mountain site (DOE 1986, Secs. 4.1.1.4 and 4.1.2.6). The adoption of these reclamation practices by the DOE was used as justification for the conclusion reached in the EA (Sec. 4.2.5) that no significant adverse environmental impacts would

result from site-characterization activities. The commitments made in the EA include general decommissioning practices and reclamation procedures consistent with the commitments made in the Mission Plan, although some additional commitments were made in the EA (see Table 1).

The DOE made a commitment in the EA to perform field studies to determine effective approaches for reclaiming disturbed areas. The Reclamation Feasibility Plan (RFP) (DOE 1988f) has been written to describe these studies. The results of studies described in the RFP will provide essential information to the overall reclamation program at Yucca Mountain (see Sec. 4.1).

2.6.3 Site Characterization Plan

Section 8.7 of the SCP contains general descriptions of reclamation activities to be conducted at the Yucca Mountain site if it is determined to be unsuitable for a repository. Specific types of reclamation activities mentioned in the SCP include (1) actions taken prior to land disturbance to stockpile topsoil and control erosion, and (2) actions taken to reclaim a disturbed area after site-characterization activities are complete and a determination has been made that the area is no longer needed for the program. These activities are consistent with those committed to in the Right-of-Way Reservation granted to the DOE by the BLM (see Table 1). The SCP states that prior to initiation of surface-disturbing activities in an area, site-specific reclamation guidelines will be developed.

3 RECLAMATION POLICY

This section describes U.S. Department of Energy (DOE) policy regarding reclamation of areas disturbed by site characterization at the Yucca Mountain site. Included are (1) objectives of the reclamation program, (2) consistency of reclamation activities, and (3) timing of reclamation. This policy follows from legislative and regulatory requirements, past commitments made by the DOE for certain types of reclamation activities at the Yucca Mountain site, and consideration of biological and ecological factors important for achieving reclamation success and minimizing any significant adverse environmental impacts.

3.1 RECLAMATION OBJECTIVE

The objective of the DOE reclamation program at Yucca Mountain is to return land disturbed by site-characterization activities to a stable ecological state with a form and productivity similar to the predisturbance state. Such reclaimed land would exhibit little soil erosion and would be capable of supporting the types of plant and animal species that were present before disturbance. All reasonable and necessary steps will be taken by the DOE to ensure that reclamation of the Yucca Mountain site is achieved.

Without implementation of an active reclamation program, the establishment of stable ecological conditions in arid environments may require decades or centuries to achieve, depending on the degree of disturbance and the environmental conditions present at the site (Wallace, Romney, and Hunter 1980; Office of Technology Assessment 1986; Webb, Steiger, and Newman 1988). Reclamation activities will reduce soil erosion, increase the rate of plant colonization and succession, and provide wildlife habitat at disturbed areas (Wallace, Romney, and Hunter 1980). Thus, reclamation will serve to mitigate the effects of site characterization on plant and animal communities at Yucca Mountain.

3.2 RECLAMATION CONSISTENCY

The Yucca Mountain site encompasses lands controlled by the DOE, Bureau of Land Management (BLM), and the Air Force. In formulating a reclamation program for the Yucca Mountain site as a whole, the DOE must take the different reclamation requirements of these agencies into consideration. In addition, some areas have already been disturbed by repository-related activities conducted before initiation of the site-characterization program. This section discusses how the DOE will incorporate these factors into a consistent reclamation program for the entire Yucca Mountain site.

3.2.1 Reclamation of Areas Disturbed before Site Characterization

Existing disturbances at the Yucca Mountain site, which involve about 375 ha (930 acres) of land, include roads, drill pads, sumps, borrow pits, power lines, equipment yards, and trenches. Some of these disturbances were caused by repository-related field activities initiated in 1978. The extent and locations of these disturbances will be determined as part of the reclamation feasibility studies planned under the Reclamation Feasibility Plan (RFP) (DOE 1988f).

Areas that were disturbed by previous repository-related activities will be reclaimed in a fashion similar to reclamation of areas disturbed by site characterization. At this time, the extent and success of interim reclamation measures (e.g., topsoil stockpiling, erosion control) implemented at each of the previously disturbed locations is not known, but site-specific reclamation instructions will be developed for each of these areas. Because access roads may have use beyond the needs of the repository program, the DOE will consult with appropriate agencies and landowners in determining final reclamation of these areas.

3.2.2 Reclamation of Areas under Different Jurisdictions

The Yucca Mountain site encompasses several parcels of land that are under different jurisdictions, including (1) the Nevada Test Site (DOE), (2) the Nellis Air Force

Base Range (Air Force and BLM), and (3) BLM-administered public lands. Site-characterization activities are planned in all of these areas. The BLM has granted a Right-of-Way Reservation, with specific reclamation requirements (see Sec. 2.3), to the DOE for access to BLM-administered lands. Although no site-characterization activities currently are planned for areas off the Yucca Mountain site on private or state-controlled lands, it is possible that some such activities could occur, depending on the information needs of the program.

The DOE will adopt a reclamation policy for all areas disturbed that is consistent with already-established BLM agreements, whenever possible. The DOE, however, will be responsive to the reclamation needs of different agencies or landowners. The DOE will consult and coordinate with the appropriate agencies and landowners in developing site-specific reclamation instructions.

3.3 RECLAMATION TIMING

To minimize significant adverse environmental impacts at the Yucca Mountain site, the timing of reclamation should be considered. Unreclaimed sites may be subject to soil erosion and may support a less productive or less diverse biotic community than reclaimed sites. In addition, the physical, chemical, and biological characteristics of stockpiled topsoil typically change over time, resulting in a reduction in plant productivity (Bradshaw and Chadwick 1980; Office of Technology Assessment 1986). To avoid the problems associated with long delays, all reclamation activities at the Yucca Mountain site will be conducted as soon as practicable following the determination that an area is no longer needed for the program. This section discusses the various scenarios and conditions that may affect the timing of reclamation activities. In all cases, decisions regarding the appropriate timing of reclamation will be based on the needs of the site-characterization program.

3.3.1 Reclamation before Completion of Site-Characterization Program

Areas that could be reclaimed before completion of the site-characterization program will include locations where no aboveground structures have been required. Examples are areas disturbed by trenching, infiltration, and geophysical studies. Areas where construction will be required (e.g., access roads, drill pads) may not be reclaimed immediately, depending upon the potential need to reuse the area. Reclamation of the Exploratory Shaft Facility (ESF) and certain other areas will await a decision on the ultimate fate of the facility in the event that the Yucca Mountain site is determined unsuitable for repository development.

3.3.2 Reclamation if the Yucca Mountain Site Is Found Unsuitable for Repository Development

If the Yucca Mountain site is found unsuitable for repository development and no alternative use for the site is found, reclamation activities will proceed immediately on those areas remaining to be reclaimed. It is conceivable, however, that the exploratory shafts, underground workings, and associated buildings might have other uses once site characterization has been completed. For example, these facilities might be used for other programs or activities by the DOE, the BLM, or the Air Force. If an alternative use is established, reclamation activities will be limited to only those areas deemed not needed for the proposed alternative use. Those areas likely to be reclaimed in such an eventuality will include all areas disturbed by field activities.

3.3.3 Reclamation if the Yucca Mountain Site Is Found Suitable for Repository Development

If the Yucca Mountain site is determined to be suitable for repository development, reclamation will be carried out in disturbed areas not needed for development or operation of the repository. Such areas likely will include trenches, seismic lines, some access roads, and drill locations. In addition, piles of excess

excavated material, muck storage areas, borrow pits, and other disturbed locations within the ESF area could be reclaimed if not needed for development or operation of the facility.

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4 RECLAMATION IMPLEMENTATION

The types of impacts caused by site-characterization activities are expected to be similar to those typically caused by large construction or mining projects. Therefore, no unusual reclamation needs are anticipated for the site-characterization program. The Reclamation Implementation Plan (RIP), which is currently being developed, will provide detailed, technical descriptions of planned reclamation activities and the methods for implementing those activities during and after site characterization. The RIP also will discuss the reclamation monitoring program and standards for determining reclamation success.

The reclamation activities planned for site characterization at Yucca Mountain are summarized in Table 2 and described below. Activities can be placed into four categories: reclamation feasibility studies, interim reclamation activities, final reclamation activities, and postreclamation monitoring.

4.1 RECLAMATION FEASIBILITY STUDIES

The Reclamation Feasibility Plan (RFP) (U.S. Department of Energy [DOE] 1988f) has been developed to describe studies that will be used to determine the feasibility and effectiveness of various revegetation techniques at Yucca Mountain. Relatively little is known about reclamation in extremely arid environments such as the Yucca Mountain site (Wallace, Romney, and Hunter 1980), and site-specific studies are needed to determine the types of practices that will most likely be successful. Investigations planned as part of the RFP include (1) studies of succession and soil conditions at previously disturbed areas on the site and (2) reclamation studies to determine the best methods for topsoil storage, revegetation of mined spoils, and revegetation trials on previously disturbed areas. The results of studies described in the RFP will provide input to the reclamation program for the site.

TABLE 2 Reclamation Activities for the Yucca Mountain Site

Reclamation Feasibility Studies

Disturbed habitat investigations
Reclamation studies
 Stockpiled soil viability and protection
 Revegetation of mined spoils
 Revegetation trials

Interim Reclamation Activities

Preactivity surveys and investigations
 Soils investigations
 Vegetation assessment
 Surveys to determine presence of sensitive species
 Assessment of wildlife habitat

Site-clearing specifications
 Vegetation removal and disposition
 Soil removal

Topsoil storage and management
 Direct replacement instructions
 Stockpiling specifications
 Protection specifications

Erosion-control measures

Drainage-control specifications

Final Reclamation Activities

Site abandonment
 Decontamination actions
 Decommissioning actions
 Prereclamation soil sampling and analysis

Recontouring

Revegetation activities
 Topsoil distribution
 Seedbed preparation
 Revegetation of site
 Mulching of site
 Supplemental irrigation

Postreclamation Monitoring

Revegetation monitoring
Wildlife monitoring

4.2 INTERIM RECLAMATION ACTIVITIES

The site-specific characteristics (topography, soils, and ecology) of each disturbed area must be taken into account to maximize reclamation success. Preactivity surveys will be conducted to obtain this information wherever surface-disturbing activities will occur. Prior to disturbance, each location will be evaluated by soils scientists and ecologists using standard survey techniques to determine the predisturbance characteristics. Data will be collected on soils (e.g., soil type, depth, and physical and chemical characteristics), vegetation (e.g., percent cover of dominant species, stage of succession), presence of sensitive species, and wildlife use. Details of the preactivity surveys are presented in the Environmental Field Activity Plan (EFAP) for Soils (DOE 1989) and the EFAP for Terrestrial Ecosystems (DOE 1988g).

The information collected in the preactivity surveys will be used as the basis for site-preparation instructions to be developed for each location that will be disturbed during site characterization. These instructions will include specifications on (1) vegetation removal and disposition; (2) soil removal, including depth and area to be removed and instructions for the direct replacement of topsoil if this is to occur; (3) location, dimensions, and treatment of the topsoil stockpile; (4) interim erosion control measures; and (5) specifications for controlling drainage.

4.3 FINAL RECLAMATION ACTIVITIES

Once site-characterization activities in a particular location are complete and a decision has been made that the area and the facilities there are no longer needed for the program, final reclamation of that area can proceed. If needed, decontamination and decommissioning of the area will first be conducted. As stated in Sec. 1.2, decontamination of disturbed areas is not expected to be necessary. Decommissioning activities will, however, be required at many of the locations. Decommissioning actions will include the removal of wastes, such as garbage, concrete, asphalt, equipment, pipes,

drilling muds, sewage, excess excavated material, wastewater, and chemical wastes. Aboveground buildings and structures will be dismantled and removed, and abandoned boreholes will be sealed.

Studies will be conducted after decommissioning activities have been completed at each location. Each study will focus on the physical and chemical characteristics of the topsoil to be used in reclaiming the area, as described in the EFAP for Soils. This information and the information collected in preactivity surveys will be used in the development of final reclamation instructions for each disturbed location. These reclamation instructions will include, as appropriate, specifications on (1) recontouring, including the amelioration of compaction (e.g., ripping and disking) and (2) revegetation activities.

Recontouring activities will be directed at stabilizing disturbed areas. All reasonable and necessary steps will be taken to establish stable contours that are consistent with the original contours and those of the surrounding terrain. In certain instances, such as when underlying bedrock has been disturbed or removed, the restoration of original contours may not be feasible. In such cases, stable, rather than original, contours will be established.

Revegetation activities to be specified in reclamation instructions for each area will include, as appropriate, details on (1) topsoil distribution, (2) seedbed preparation, (3) revegetation methods (seeding, transplanting, etc.), (4) mulching, and (5) supplemental irrigation. These activities will serve to establish a permanent vegetative cover on disturbed areas.

Areas disturbed before site-characterization, but as part of the repository program, also will be evaluated prior to reclamation. Data collected from each such area will be evaluated as part of the studies described in the EFAP for Soils and the RFP. This information will be used to determine the appropriate reclamation strategy for each location consistent with the overall reclamation program at Yucca Mountain.

4.4 POSTRECLAMATION MONITORING

To meet the objectives of the reclamation program, it will be necessary to monitor, over a period of years, the success of reclamation practices. A variety of circumstances, especially unusual weather, could produce the need for further action once initial reclamation activities are complete. Monitoring will reveal the need to reseed, fertilize, irrigate, or take other actions to promote revegetation of disturbed areas.

The results of field studies described in the RFP will provide information for the development of a successful reclamation strategy. Those studies also will identify the problems that could occur in establishing native vegetation on disturbed areas and will be helpful in establishing reclamation criteria. Criteria will be set, based on predisturbance conditions determined in preactivity surveys, to evaluate the success of reclamation at a given location and to determine whether other actions are needed to improve the results. Postreclamation monitoring and reclamation criteria will be described in greater detail in the RIP.

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6 GLOSSARY OF TERMS AND LIST OF PRINCIPAL ABBREVIATIONS

6.1 GLOSSARY

Decommissioning -- Steps taken to place a facility in a permanently nonoperable, safe condition.

Decontamination -- Selective removal of radioactive contaminants from an area.

Final reclamation -- Reclamation activities conducted after site characterization has been completed in an area.

Interim reclamation -- Reclamation activities conducted before and during disturbance of an area.

Postreclamation monitoring -- Monitoring conducted to determine the success of completed reclamation activities in an area.

Preactivity survey -- Survey conducted to determine soil, ecological, and archeological characteristics of an area before disturbance.

Prereclamation study -- Study conducted in an area after site-characterization activities are completed to provide input to the development of final reclamation instructions.

Reclamation -- Those activities employed to return land disturbed by site-characterization activities to a stable ecological state with a form and productivity similar to the predisturbance state.

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Reclamation instructions -- Detailed site-specific instructions used to carry out interim and final reclamation activities in an area disturbed by site characterization. Reclamation instructions would incorporate information gathered in preactivity surveys and prereclamation studies.

Reclamation criteria -- Criteria or standards used to evaluate the success of reclamation activities at a disturbed area.

6.2 PRINCIPAL ABBREVIATIONS

BLM -- Bureau of Land Management

CEQ -- Council on Environmental Quality

CFR -- Code of Federal Regulations

DOE -- U.S. Department of Energy

EA -- environmental assessment

EFAP -- Environmental Field Activity Plan

EMMP -- Environmental Monitoring and Mitigation Plan

ERCP -- Environmental Regulatory Compliance Plan

ES-1 -- Exploratory Shaft No. 1

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